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Subject: Comments on the report titled "Evaluation of the San Jacinto Waste Pits Feasibility Study Remediation Alternatives", US Army Corps of Engineers (USACE), Engineering Research and Development Center (ERDC), August, 2015

Dear Gary,

Thank you for soliciting technical support from the US Army Corps of Engineers (USACE) by requesting an independent evaluation of the proposed San Jacinto Waste Pits Feasibility Study Remediation Alternatives. Providing an independent assessment and evaluation of the remediation alternatives at this juncture in the Superfund process is welcomed and critically important. We also appreciate the opportunity to review and provide comments on the draft USACE evaluation report. As we move closer towards the development of the final feasibility study for the San Jacinto Waste Pits Site (Site) it is imperative that reports, such as this one, are benefited by stakeholder review, comment and revision, with the intended goal being a comprehensive final record for future reviewers and decision makers.

As stated in previous comment letters, The Harris County Technical Review Team (Technical Review Team) believes that the full removal alternative, as a permanent solution, will significantly reduce the risk to human health and the environment and remains the best remedial alternative. The Comprehensive Environmental Compensation & Liability Act (CERCLA) requires and prefers remedies that permanently and significantly reduce the volume, toxicity, or mobility of hazardous substances, so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment. Leaving such toxic materials in place in a floodplain and aquatic environment is not a permanent or appropriate solution given the frequency and severity of tropical storms, floods, tidal action and hurricanes that affect the areas, as well as subsidence activity.

For comment discussion purposes the Site was divided into three sections, as follows:

1. Western Cell – Generally above water. Existing cap is geotextile filter, geomembrane, geotextile cushion and armor stone. Soft sediments were solidified/stabilized prior to cap construction.
2. Eastern Cell – Generally covered with less than 5 feet of water. Existing cap is geotextile filter and armor stone.
3. Northwestern Area – Generally more than 10 feet of water depth. Existing cap is granular filter blended with armor stone. There is no geotextile in this area.

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General Comments

Can we state with high confidence that the cap will prevent any release of contaminated material from the Site for 500 years? We believe not, for the following reasons:

1. **Uncertainty on lifetime of geomembranes.** The containment of dioxin relies heavily on geotextiles and geomembranes. There is considerable uncertainty regarding the projected lifetime of polyethylene geomembranes. Polyethylene is subject to natural oxidation, among other weaknesses, and its long-term functionality is expected to depend on its thickness, quantity of antioxidants, and the environmental conditions (e.g., temperature, oxygen content, mechanical stresses) to which it is subjected. The available evidence, as reviewed by Rowe and Sangam (2002) and Müller et al (2003), does not appear to support a containment lifetime as long as 500 years for HDPE. LLDPE is considered even more prone to oxidative weakening than HDPE. We are not aware of evidence supporting a conclusion that the geomembranes upon which the armored cap relies for effectiveness will remain intact for 100, 250 years much less 500 years.

2. **Challenges to installing geomembranes.** Based on experience elsewhere, installation of geotextiles and geomembranes can be very challenging – small perforations and seam leakage may be common (Muller, 2007). For example, Nosko (1996) reported that of 94 geomembrane installation sites inspected using an electrical leak detection system, only 23 had no faults. Most of the damages were caused by placement of the overlying rock or soil layer. Thus, there is at least a reasonable possibility that small amounts of leakage may already be occurring in some areas.

3. **Diffusion from eastern and northwestern area of Site.** Though diffusion may be slow, over time a significant portion of the total contaminant mass in the Eastern cell and Northwestern area (that lack an impermeable geomembrane) will escape from the wastes pits due to tidally-enhanced diffusion/advection of pore water from the wastes. This would occur in the absence of any defect or damage in the cap or geotextile.

4. **Verification of cap integrity**. The proposed cap sampling plan to confirm the absence of dioxin migration from the cap and the toe of the cap has not been completed. As a result, there is not sufficient data to support a conclusion that the cap has retained its integrity now, and no evidence to support a conclusion that it would remain intact for 500 years.

5. **Failure to evaluate severe storm impact on cap.** Though future meteorological and hydrologic conditions are debatable, it is at least a reasonable possibility that a storm, or combination of storms, may occur in that period that is substantially more severe than the 1994 storm that was simulated in the models. Neither Anchor QEA nor the USACOE Project Delivery Team have evaluated impacts of storm surge or strong wave action associated with a major hurricane, nor the worst case scenario of a "wet" Category 5 hurricane. In the absence of such an analysis, it does not appear defensible to argue that the existing cap with remain intact for 500 years.

6. **Failure to evaluate land subsidence and sea level rise.** The impact on cap performance of land subsidence and sea level rise, together with their inter-related impacts on site exposure to recreational boating and barge traffic, have not been adequately evaluated, or the combination of sea level rise with a category 5 hurricane over the next 100 years with a degraded geotextile.

7. **Impact of vessel collisions with cap.** Even in the absence of a reduction in cap function, there is a reasonable possibility that an accident of some sort will damage the cap over that period of time. It could involve barges, tugboats, recreational fishing, transportation accidents, or utility or transportation-related construction.

8. **Unacceptable uncertainty involved in leaving sediment contaminated with dioxin in place for 500 years.** In Study Task 7, the USACE Report assessed the long-term (500 years) reliability of the cap. It is significant to note that the first topic they discussed was the uncertainty in their assessment. The USACE Report establishes that the uncertainty involved in leaving the contaminated sediment in place are unacceptable. The USACE Report states:

> *It is the PDTs [project delivery team's] professional judgment that the uncertainty inherent in any quantitative analysis technique used to estimate the long-term (500 years) reliability of the cap is very high. This includes the empirical analysis developed by Maynord (2000) to estimate the potential scour of the cap due to prop wash generated by ship traffic since a lot of the site data needed to properly perform this analysis were not available. The latter analysis probably has the smallest uncertainty associated with any of the tasks under the Task methodology given above, and its estimated uncertainty is at least ± one order of magnitude. So, if the estimate of prop induced scour is 10 cm, then than (sic) range of uncertainty would be from 1 cm to 100 cm.*
>
> *The uncertainty associated with estimates of the impact of the three processes listed under the forth bullet above on the long-term reliability of the cap would be even larger*[1] [Note: the three processes are toe erosion, movement of armor rock during a flood and erosion of material below the cap and changes in river flow dynamics and channel morphology].

USACE's statements cited above are a very important factor in evaluation of the long-term reliability of capping alternatives. The analysis with the most accurate predictions has uncertainty of at least one order of magnitude (that is a factor of 10!). The uncertainty of the other analyses is even greater. As an example, this means that if the models predict toe erosion of 3 inches, the actual amount that may occur over a 500 year time period will range from less than 0.3 inches to more than 30 inches. In this paragraph, the PDTs experts are explaining that it is not possible to make accurate predictions of severe events over a 500 year time period.

The uncertainties in predictions must be carefully considered when comparing capping alternatives to removal alternatives. There are also uncertainties in predictions of sediment resuspension and residuals for removal alternatives (with excavation in the dry or dredging in the wet). However, higher than

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USACE 2015 p. 42

predicted releases can be managed and controlled during removal, but are **uncontrollable** with capping alternatives.

During implementation of a removal alternative, monitoring will be done to measure and quantify the mass of contaminated sediment particles at the perimeter of the work area. If monitoring showed levels above acceptable levels, then the work would be immediately stopped and the methods used to remove sediment would be modified. On the other hand, if a cap was damaged or eroded in future years, there would not be any way to limit or control release of contaminated sediment into the environment. In fact, there would be no way to even know that a release occurred until after the event had occurred. Once contaminated sediment is released, it is impossible to retrieve all the lost material.10.

9. Executive Summary disconnect. The Executive Summary (ES) is very different from the report and is not really a summary of the report. It does not adequately describe the report findings. As currently written, a reviewer reading the ES alone and not the report in its entirety would conclude that leaving the dioxin contaminated waste in-place as proposed in the Enhanced Cap Alternative 3N is a preferable option over a removal alternative. That remediation preference is not fully supported by the report.

The Executive Summary needs to be substantially revised after completion of work that was not done at the time of the reports (i.e. modeling in Study Task 14 and evaluations in Tasks 18 and 19). The lack of funds to perform these studies in no excuse for putting the Houston and Galveston fisheries and economy at risk for hundreds of years. Additionally, the ES needs to be revised upon completion of the proposed sampling plan geared towards assessing current cap integrity.

There are statements in the ES that are not consistent with the text of the report. Examples are:

- In the Permanence of Capping section, the USACE Report says that losses from cap damage during unusual catastrophic events would be small, comparable to losses from removal of contaminated sediments for dredging alternative 6N. There is no basis for this statement because (a) the USACE Report does not provide quantitative estimates of releases for the capping alternative and (b) predicted losses will be much less than predicted for the FS alternative 6N with the use of the best management practices described in the new full removal alternative. It is also not clear what an "unusual catastrophic event" would be. Over a 500 year period, there is a high probability that the site will be subject to extreme events such as flood flows, storm surges and hurricanes followed by periods of high precipitation.

- In the Permanence of Capping section, the USACE Report says that Task 8 shows that if the cap were impacted by a barge strike the potential losses would be less than the losses from a complete removal alternative. The USACE Report did not provide a quantitative estimate of releases from barge strikes or how many strikes would occur in 500 years.

- The Effectiveness of Dredging section neglects to include mention of the benefits of use of best management practices described in Task 6 or the effectiveness of a new full removal alternative in Task 12 and 14.

- The Impacts of Remediation section needs to be updated after completion of the modeling in Task 14.

- In the second paragraph of the Impacts of Remediation section, there are statements that are not supported by the USACE Report text. Example are:
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  - The text says fish tissue contaminant concentrations are expected to be several times greater than existing concentrations for several years. There is no basis given to support this statement.

  - The text says that the short term losses are comparable to the losses expected across the entire site and 100 times the predicted losses from an intact cap. This statement is unclear because the potential short-term releases to the river depend on what best management practice are employed and it does not consider the risk of uncontrolled releases from a damaged cap or from the cap were geotextile liner is not in place or even the amount of release that is currently occurring due to constant tidal action through pore water.

Specific Comments

1. **Study Task 2 Assess San Jacinto River flow and bed scour.**

The authors state that *"eustatic sea level rise and subsidence also contribute to the vulnerability of the Site."*[2] However, while stating that the combination of these two factors has resulted in a 1.97 foot change in relative sea level over the past 100 years, they do not attempt to simulate scenarios that involve reasonably expected future sea levels, continuing land subsidence, and climate impacts on storm intensity. We understand that there is a large amount of uncertainty regarding projecting these to the end of the century, not to mention a 500-year period. Climate models project that an increase in global temperatures will result in an increase in the frequency of heavy precipitation events and in intense storms. The USEPA has recently released a Climate Assessment Tool to permit evaluation of climate change impacts on their BASINS suite of water quality models.

In a hurricane, the cap will be subject to shear stresses from both currents and waves. The shear stress exhibited by combined wave and current action is a non-linear combination of the two stresses and can be much greater than that caused by the current alone. **The USACE Report notes that wind waves are not simulated, and should have been evaluated for storm conditions.** The authors note that a "wet" hurricane could be considered a worst-case scenario, but they did not attempt to simulate it. There may be more extreme scenarios that should be considered. For example, the maximum design flow at the Lake Houston spillway is 525,000 cfs – approximately 50% higher than the peak flow in the 1994 flood. We believe that the models should be applied with a reasonable worst-case wet hurricane

[2] USACE 2015 p. 7

event together with variable levels of sea level rise. A similar 1.97 foot rise per 100 years could be used, based historical data.

The USACOE report states "Storm surges generated in the Gulf of Mexico propagate into Galveston Bay and into the Lower SJR. Storm surge modeling conducted by NOAA predicted that category 3 and 5 hurricanes that hit Galveston Bay during high tide would produce surge levels of 23 ft (7.0 m) and 33 ft (10.1 m), respectively, at the Site."

The recurrence interval of a category 3 or greater hurricane striking Harris County is on the order of 25 years (Keim et al., 2007). The impacts of a worst-case scenario, such as a "wet" category 5 hurricane on the capped waste pits should be evaluated. Investigators at the SSPEED Center at Rice University has developed a technique using existing datasets from recent hurricanes, shifting of historical hurricane rainfall and wind fields based on alternate landfall locations, to develop synthetic hurricane datasets that represent events with a longer expected recurrence interval (http://speed.rice.edu/sspeed/downloads/HGAPS_Report_08_31_15.pdf). For example, they applied measured data from Hurricane Ike, shifting its point of landfall to Galveston Island, to approximate impacts from a 100-year hurricane for Galveston Bay and the Houston Ship Channel. We recommend this approach to provide appropriate conditions for evaluating the impact of a 500-year event on the capped waste pits.

The USACE Report should consider how submersion of the Western Cell would impact performance of its cap.

The USACOE project delivery team seems to have adopted in their LTFATE model, without question or evaluation, most of the assumptions and inputs to the Anchor QEA EFDC model. It may have been better for them to start from scratch, using conservative assumptions. The USACE should not accept these inputs without verification.

When the LTFATE model predicted a maximum scour of 5.9 feet for the 1994 storm, while a maximum of 10 feet was reported at the time, the authors question the accuracy of the report rather than the accuracy of the model or the data and assumptions that went into the model. At a minimum, this needs to be discussed regarding the uncertainty of the model's scour predictions.

2. **Study Task 3 Evaluate model grid cell size used by PPRPs and discuss model uncertainty.**

In a USACOE document (2013) "Review of Design, Construction and Repair of TCRA Armoring for West Berm of San Jacinto Waste Pits", Dr. Paul Schroeder reported that the cap design should have considered wave runup and overtopping. He states "under wave runup and overtopping, significant vertical velocities and turbulence are generated at small scales. These velocities in the immediate vicinity, within 1 to 2 meters, of the west berm generate much greater shear stresses than in a uniform flow field." He further states that the two-dimensional, vertically-averaged model with 15m x 15 m resolution "may not be adequate in the immediate vicinity of the berm to estimate the maximum shear stress along the length of the berm. The steepest section of the berm cross-section is one to two meters in length and the crown of the berm is only 2.5 meters wide; which cannot be well represented with a 15 x 15 m grid cell resolution. Similarly, the impacts of estimated waves during the design events should be included in the analysis to compute the maximum stable particle size. Wave induced velocities on slopes may be about 25% greater than simple advective velocities and shear stresses may be 60% greater." We believe that it is necessary to evaluate the impact of wave action, with and without storm surge, from a major (Category 5) hurricane, as this can reasonably be expected to impact the Site over the next 500 years.

We do not necessarily agree with the statement in the USACE report that "it is standard to evaluate the effects of uncertainties in model inputs using a sensitivity analysis." In our opinion, an uncertainty analysis should involve more than just varying a tiny subset of model parameters, as performed by Anchor QEA, but include uncertainties in input datasets, model equations and assumptions, and calibration accuracy. We acknowledge that this is a daunting task for a complex environmental model. It is not clear yet to what extent the USACE will consider these factors in their Expanded Sensitivity Analysis.

3. **Study Task 5 and 6 Technical review of existing cap and assess ability of existing cap to prevent migration of dioxins.**

Western Cell: The USACE Report stated that the cap should be stable provided that all the surfaces were flatter than 3 horizontal to 1 vertical (3H:1V).

Eastern Cell: The USACE Report stated that the cap should be stable provided that all surface are flatter than 3H:1V. The USACE Report states:

> *The diffusive flux of contaminants from the capped area is very small compared to resuspension losses of contaminated particulates prior to capping; however, the diffusive losses from the sediment are largely unimpeded by the cap. The armor cap material does not have a significant quantity of organic carbon to retard contaminant transport. In addition, the large pore structure of the armor cap material would permit a large exchange of water within the cap, preventing the formation of a concentration gradient to slow the diffusion.*[3]

Northwestern Area: The USACE Report states that the cap in the Northwestern Area does not provide the same level of confidence in its long-term stability and performance as in the other two areas. There are potential contaminant loses due to diffusion, pore water expulsion, tidal pumping and groundwater seepage.

Slopes within the Northwestern Area are as steep as 2H:1V. The USACE Report recommends placing cap material and blended filter material on slopes no steeper than 3H:1V and preferably less than 5H:1V.

Benthic organisms may burrow down to a depth of 12 to 15 inches below the sediment surface in areas where there is no geotextile or geomembrane. The area lacking a geomembrane is subject to greater erosion and contaminant migration.

The USACE Report notes that the geotextile fabric over submerged portions of the Eastern cell is not intended to limit diffusion of contaminants dissolved in the pore water of waste materials into overlying water, but to limit re-suspension of sediment and sediment-associated contaminants. Temporary well SJMWS04 showed a very high concentration of over 3700 pg/L dioxin/furan toxicity equivalents, which is over the State's PCL for Class I Groundwater. It can be shown that tidal pumping will

[3] USACE 2015, page 38

enhance the rate of transport of dissolved contaminants several times higher than that expected from diffusion alone. We note that this process was not considered in the RECOVERY model. Also, though the tidally-enhanced diffusion process may be slow, over time the truly-dissolved concentration (or fugacity) of the contaminants in the overlying cap water is expected to equal that in the wastes itself.

The pore water measurements by the University of Texas researchers were performed shortly after cap installation; they should be repeated periodically and mirror the sampling recommendations outlined in the proposed EPA cap sampling approach. If any biota colonizes the cap, they will be exposed just as if they are in the waste material. The investigators have recommended the inclusion of an amendment such as AquaGate or Sedimite to the cap, but these too have limited capacity to absorb contaminants relative to the great mass in the waste material, and would only delay the time before biota would be exposed to the concentrations in the wastes.

Damage to the cap, including exposed geomembrane, has been observed after only a few years and relatively minor storms. An earlier investigation showed that an unsorted mixture of gravel and armor stone comprised the cap in places, and that this was not physically stable.

In summary, the USACE Report recommends that the cap and blended filter be placed on slopes flatter than 3H:1V to ensure physical stability of the cap and prevent migration of blended filter material downslope. It says that making the cap thicker would virtually eliminate potential resuspension loses by bioturbation. It is critical to maintain an adequate filter layer between armor stone and contaminated sediment.[4] We agree that these recommendations will improve the cap performance, but do not agree that the cap will be effective over a 500 year period for the reasons explained in our comments.

4. **Study Task 7 Assess long-term reliability (500 years) of the cap under events such as severe storms, hurricanes, and propeller wash.**

As discussed above under General Comments, the first topic addressed in this task by the USACE's experts is the uncertainty in assessing the long-term reliability for a 500-year period. The USACE Report authors state that *"the uncertainty inherent in any quantitative analysis technique used to estimate the long-term (500 years) reliability of the cap is very high"*. The high level of uncertainty in quantitative analysis (or modeling) over a long term is a very important aspect to understand in evaluating the long-term effectiveness and reliability of capping.

The USACE Report estimated the reliability for a 500-year period by analyzing multiple 100-year floods. They assumed that the 100-year floods were equally spaced in time. They did not consider "worse-case" scenario of 100-year floods in consecutive years. They did not consider a 500-year flood flow and did not consider a hurricane. The USACE Report refers to work in Study Task 14, however, that work was not completed at this time of this report. In addition, subsidence along with hurricanes and 500 year flooding should be evaluated when considering the Houston area long term effects.
The USACE Report states:

> *Assuming that any localized damage to a portion of the cap was repaired following a major flood or storm event, then it is not unreasonable to assume that in between several*

[4] USACE 2015 p. 40

> *significant flood events over the duration of 500 years, the mean bed elevation at the Site will approach the pre-flood mean bed elevation.*[5]

Although the amount of localized damage was not quantified in the USACE Report, this statement does acknowledge that there is a risk of loss of cap material during a flood, which would result in an uncontrolled release to the environment. In addition, it assumes no subsidence.

The impact of prop wash was not complete at the time of this report.

The USACE Report did not model the impact of a storm surge. The USACE Report included the following statement:

> *Qualitatively, the impact of a storm surge on the Site, and specifically on the existing cap, would be similar to the 100 year flood that was simulated. The deeper waters and higher current speeds above the cap would result in a similar amount of net erosion of the cap as was predicted during the 100 year flood event. The worst case scenario would be the combined impact of a storm surge and extreme flooding in the SJR caused by high precipitation during a so-called "wet" hurricane. It is believed that such a worst case scenario would result in a potentially much higher quantity of net erosion.*[6]

The USACE Report did not reference the design and construction concerns and corrective actions cited in the November 1, 2013 USACOE report. As discussed in our comments on Study Task 2, storm surge needs to be modeled. Additionally, projected sea rise and subsidence should be factored into models as this is supposed to provide 500 year protection.

The USACE should assess the long-term durability of the stone material used for the cap armor. Stone materials are subject to deterioration over time due to natural weathering processes. Different types of stone deteriorate at different rates, so the assessment needs to determine the type of stone used on the cap and estimate its durability.

5. Study Task 8 Impact of Barge Strikes

The USACE Report considered the potential for barge strikes under different scenarios of water depth and river flow conditions The USACE Report estimates a probability of 1 in 400 for a significant barge strike to occur in a year and a probability of 1 in 50 for a low-impact strike. For an event with a probability of 1 in 400 in a year, the probability of occurrence in 500 year time period is 71%. For an event with a probability of 1 in 50 in a year, the probability of occurrence in 500 year time period is 99.996%. Under some scenarios, a barge strike is predicted to gouge out the cap material and expose contaminated sediment.

The USACE Report makes the following statement for the Northwestern Area where the water depth is over 5 feet and the side slopes are steeper than 5H:1V:

> *The water depth is too deep for the slope to be struck by anything other than a loaded barge; a loaded barge would strike at mid-slope and potentially gouge a seam several feet*

[5] USACE 2015 p. 43
[6] USACE 2015 p. 44

> *wide and up to 100 feet long in the armor if the cap is struck obliquely. This potentially could cause sloughing of armor on the upper half of the slope,* ***exposing as much as several thousand square feet of highly contaminated sediment under its existing slope of 1V:2H.***[7]

In the event of this type of barge strike, there would be a risk of uncontrolled release of the exposed contaminated sediment. For this reason alone, complete removal of the highly toxic waste is justified. A single barge strike could have devastating effect on the environment. If this were to happen during a storm, it could be catastrophic.

The USACE Report states that the impact of strikes during high flood flows are much greater due to potential erosion of exposed sediment; however, flood conditions occur only about 1% of the time so these impacts are unlikely. The USACE Report does not consider the fact that it is much more difficult to control barges during periods of high flood flows or that there is an increased risk of barges breaking free from tugs or moorings during storms when there are high winds and high flood flows. Contrary to assertions in the USACE Report, we believe that barge strikes and grounding are rather more likely under flood (and hurricane) conditions, when they may break free from their moorings. This is exemplified in the cover photo of the USACOE report. We do agree that strike control measures such as pilings are warranted to protect from barge strikes if full removal is not performed. If pilings are used, they should be positioned sufficiently distant from the cap so that recreational boats, which will inevitably tether to them, will not swing and impact the cap.

Based on the fact of local barge operations on the Northwest side of the site and our observations of barge and tugboat operations and maintenance in the Houston Ship Channel system generally, and near the I-10 Bridge in particular, we believe that the probability of a minor strike from a barge or tugboat is significantly higher than stated (1 in 50 years). Even more likely, though likely impacting a much smaller area, would be impacts from recreational boating and fishing. The potential impact of a barge strike on the cap was judged to be, at most, moderate. The impact of exposing a thousand square feet of waste material to the River might indeed only be moderate if the damage was reported and soon repaired. It is perhaps more likely that the damage would not be reported, and perhaps not discovered for significant time or that a major event would happen in a flood. A substantial mass of waste and contaminated sediment would then be permitted to mix into the River. Damage to the toe of the cap may also cause a slope failure that could potentially threaten the integrity of the whole cap, especially in floods and release significant chemicals.

6. **Study Task 10 Document cases of armoring breaches relevant to the San Jacinto site.**

The USACE Report performed a literature review to research documented cased of breaches in armored caps or armored confined disposal facilities. They did not find any case of breaches in armored caps; however, there have been many occurrences of breaches and slope failures in armored dikes, jetties and breakwaters. The USACE Report includes a table that summarizes the breaches at 10 sites in the United States and gives the following summary:

> *The cases shown in Table 10-1 represent varying situations that may be of some relevance to the San Jacinto site investigation because the site is adjacent to a well-traveled waterway with significant wave action due to navigation, is subject to large storm events that may cause large inflows of water from overtopping the CDF, and has armored slopes with*

[7] USACE 2015 p. 48

> *synthetic material acting as a filter or liner that is susceptible to tears that allow erosion to degrade the system. None of the listed cases completely breached or failed and were discovered by routine inspections.*[8]

The literature review shows that there have been breaches in armored caps in conditions similar to those are the Site.

7. Study Task 11 Assess potential resuspension and residual under capping, solidification and removal alternatives.

In this section, the USACE Report made quantitative estimates of the mass of sediment particles and mass of contaminates released to the water due to sheet pile installation/removal, removal of existing armor cap materials, removal of existing geotextiles, and dredging in the wet (i.e. removal of sediment from underwater using dredging equipment). The USACE Report also made quantitative estimates of the post-dredge residual concentrations. These were made for FS alternatives 4N, 5N, 5aN, and 6N. The methods used in the USACE Report to make quantitative predictions are reasonable and were done using state-of-art methods. However, even the best methods require a number of assumptions of input parameters and there is significant uncertainty in the results.

For several key input parameters, the USACE Report used assumptions to make estimates of the "worse-case" scenario. As a result, the predicted releases are biased high and the actual releases will be less than predicted in the report.

One example is that the FS stated that upland portions of alternative 5sN could be performed in dry conditions. However, the USACE Report assessed the alternative based on the assumption that the work was performed in the wet. The USACE Report should be revised.

Table 11-20 presents a summary of the estimated "losses" for each alternative with the use of silt curtains or sheet pile as containment measures. Although not explicitly stated in the text, the total estimated mass reported as "lost" is the sum of the mass of resuspended sediment predicted in Tables 11-3, 11-4, 11-7 and 11-13 for sheet pile installation and removal, geotextile removal and mechanical dredging, respectively. For the sheet pile options, the majority of the predicted sediment mass resuspended is from dredging and geotextile removal (e.g. For alternative 6N, 760 metric tonnes were from dredging loss in Table 11-13 and 53.6 tonnes were from geotextile removal in Table 11-7, which accounts for 814 of the total of 821 tonnes shown in Table 11-20.) It appears that the USACE Report is making the assumption that all the material that becomes resuspended will become material "lost" during dredging operations. This substantially over-predicts the actual mass that will be released to the surface water because a portion of the resuspended sediment will settle before the sheet pile is removed. Additionally, engineering solutions can be employed to reduce resuspended sediment release.

The estimates of post-dredge residual concentrations were made using the "worse-case" scenario by assuming that residuals were 9% of the dredged mass. This is based on a paper published in 2006, which is based on analysis of residuals taken from published studies that were available at that time. The 2006 paper gives a range of residual mass of 5 to 9% of the dredged mass. This paper does not consider improvements in equipment or dredging methods, which will result in lower residual sediment.

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[8] USACE 2015 p. 66

Even with the assume residual of 9%, the calculations presented in Table 11-17 show that the residual concentration will be 71 and 18 ng/Kg for the locations where the dredging will be done down to sediment with in-situ concentrations of 53 and 8 ng/Kg (see Table 11-15). As noted in the text of the USACE Report, the predicted residual concentration of 6,840 ng/Kg for alternative 5N is the result of not dredging deep enough to reach sediment with a concentration below the PCL of 220 ng/Kg[9]. For the analysis, it was assumed that dredging stopped in sediment with in-situ concentration of 6,660 ng/Kg. If deeper dredging was assumed, then the predicted residual concentrations would be lower, as shown for other alternatives. This should be revised in the USACE Report.

In the scenarios involving placement of a sheet pile wall, the results are highly dependent on the sediment dioxin concentration in the material in which the sheet pile is placed. The model assumes the sheet pile wall would be installed to 15 feet deep in sediments with uniform dioxin TEQ concentrations of 1,000 ng/kg for alternatives 4N and 5N, and 200 ng/kg for alternative 5aN. However, there is no reason the wall needs to be installed right at the excavation boundary; it should be placed at some distance from the excavation, where concentrations are less than 50 ng/kg at the surface and (in most cases) decline with depth. Even if the sheet pile wall were placed at the locations with surface concentrations of 1,000 ng/kg, the concentrations typically decline with depth such that the average concentration that adhered to the 15 feet of sheet pile would likely be at least an order of magnitude lower than at the surface. This should be revised and appropriate engineering methods included which would placement of sheet pile as suggested.

The assumption that the removal of the sheet pile would pull a layer of sediment with an average thickness of 0.8 cm thick with it may or may not be an overestimate. If it is that cohesive, it will fall back to the sediments in large globs or be removed with the sheet pile.

It seems that if the sheet pile wall were installed on or slightly outside of the perimeter of original impoundments, the dioxin releases during its installation would be minimal because the sediment concentrations are mostly less than 50 ng/kg. It is more logical to assume you would not install sheet pile into the sediment where the concentrations are the highest. A silt curtain may also be used in the northwest corner where water is deep. The wall should then minimize releases of dioxins during cap removal, excavation, and dredging. Removal of the sheet pile wall may not be beneficial or necessary, but if it was, it would release relatively little dioxin again because it is placed in material with dioxin concentrations less than 50 ng/kg.

The dredging calculations appear designed to maximize calculations of release of dioxins. They assume an estimate of average 10 feet water depth, with dredging to 10 feet plus 1 foot of overdredge. However, almost all of the area requiring dredging would be in less than 4 feet of water. In most of the Eastern cell, the sediment vertical cores imply that in most spots dredging to four of five feet would be sufficient to reach the remedial objective. Therefore, this section of the USACE Report should be revised.

All of the scenarios evaluated and all of the assumptions regarding material removal seem substantially biased to overestimate the loss of dioxins from the Site and not use the best engineering control techniques possible today.

[9] USACE 2015 p. 89

The USACE Report has the following in the Conclusion of this study task:

> *Any remediation, solidification or dredging, that occurs should be completed in the dry to minimize the amount of resuspension losses and residuals that may be exposed to the water column, particularly in the area slated for removal in Alternative 5N. All activities completed in the dry, having a sheet pile wall barrier protecting the water from interacting with contaminated sediment will result in very small amounts of resuspension, and will have limited exposure to the water before the permanent cap is placed over the residual layers.* [10]

We agree with the above statement. The USACE report should evaluate a full removal alternative that uses the best management practices they recommend.

8. Study Task 12 Identify best management practices to minimize sediment resuspension and residuals

In this task, the USACE Report describes best management practices and dredge methods to minimize sediment resuspension and post-dredging residual. In addition, this section evaluates a new full removal option using recommended best management practices.

The new full removal option is based on the following conditions:

- Western Cell: Excavate in the dry by constructing a berm on the north side. Install sheet piles through the berm to raise the effective height to provide protection from storm flows, tidal fluctuations, and wave for 10-year flood events.
- Eastern Cell – Shallow-water portion: Install sheet piles on the north and east sides and tie into existing berms on the south and west side. With the sheet pile in place, the predicted sediment loses were based on removal of the existing cap and geotextile, resuspended material during sheet pile install/removal and an assumed loss of all material suspended during dredging operations.
- Eastern Cell – Deep-water portion: It was assumed that a sheet pile wall would be installed around this area. However, it was assumed that all the sediment resuspended during dredging was "lost" (i.e. migrated outside the sheet pile and into the surface water).
- Northwestern Area: It was assumed that a turbidity curtain would be used since the average water depth is 15 feet. The text states that this depth makes it somewhat impractical to confine with a sheet pile.

With the above condition, they calculated sediment and contaminant losses using the same methods as in Task 11 and the results are presented in Table 12-19.

A comparison of the predicted sediment and contamination loss for Alternative 6N as described in the FS and with best management practices is shown below (based on Tables 11-20 and 12-19). For the new alternative, most of the predicted loss was from the Northwestern Area, where the USACE Report assumed silt curtains would be used.

[10] USACE 2015 p. 88-89

Alternative	Control Method (BMP)	Mass of dry solids "lost" (metric tonnes)	Mass of contaminant "lost" (g)
6N	Silt curtains	3,410	19.6
6N with sheet pile	Sheet piles	821	4.56
New Full Removal	Sheet piles, excavation in dry where feasible, silt curtain in Northwest Area	430	1.57
New Full Removal without Northwestern Area	Sheet piles and excavation in dry	91	0.32

The mass of material estimated as "lost" in the above tables could be substantially reduced further by the following:

- In the analysis, it was assumed that all sediment resuspended by dredging in the East Cell would be released outside of the sheet pile enclosure by interchange of water, which the USACE Report assumed was required to maintain equal hydraulic pressure on both sides of the wall.[11] This could be eliminated by designing the wall to prevent water flow
- It was assumed that sediment was removed from the shallow water portion of the East Cell by dredging in the wet. As stated on page 121, it would be possible to excavate this portion of the site in the dry, which would further reduce the predicted contaminant release.
- Sheet pile or cofferdams can be constructed in water depths of 15 feet, so it is feasible to provide better containment in the Northwestern Area.

In the Conclusion section of Task 12, the USACE Report states:

> *It is recommended that whenever possible, activities should be completed in the dry such as the shallow water portion of the Eastern Cell. By constructing a berm and sheet will (sic)l wall structure, the area can be completely dewatered and all activities can be completed in the dry. Losses in the deep water section of the Eastern Cell can be greatly minimized if a sheet pile wall is utilized and does not allow residual losses. There will also be limited exposure to the water before the permanent cap is placed over the residual layers if a sheet pile wall is used.*[12]

The USACE Report should be revised to state that it is feasible to completely enclose the West and East Cells with berms or sheet piles that would be designed to contain sediment that would be

[11] USACE 2015 p. 115
[12] USACE 2015 p. 130

resuspended during removal of existing armor and geotextile and during mechanical excavation or dredging. In the portions of the cells where dredging in the wet was used, backfill could be placed before removing the sheet pile to reduce potential erosion of post-dredge residual contamination.

We believe that the USACE Report should consider additional benefits of removing the wastes more effectively as described above. A significant and primary long-term benefit would be a substantial reduction in uncertainty regarding the severity of a potential worst-case scenario of future exposures of humans to dioxins of the next 500 years. A secondary benefit would be lower long-term maintenance costs to future generations.

9. Study Task 13 Assess validity of statements in the FS that removal, solidification and placing waste again would result in significant releases

The USACE Report evaluated several statements in the FS related to short-term loses during dredging operations. The USACE Report notes that FS was inconsistent in the BMP and methods of removal between alternatives. For example, the USACE Report says:

> *As an example, it appears that removal in the Western Cell is performed in the dry with landside operations in Alternatives 5N and 5aN, while its removal is performed in the wet in Alternative 6N. Similarly, removal in Alternative 5N is performed with a sheet pile wall to control losses while in Alternative 5aN removal within the footprint of Alternative 5N within the Eastern Cell is performed with a silt curtain, allowing greater losses from an area with very high contaminant concentrations. Ideally, removal in the Western Cell would be performed in the same manner in all of the alternatives so that one can understand the costs and benefits of expanding the footprint of remediation or removal.* ***Consequently, the performance of the alternatives as predicted in the fate and transport modeling tends to distort the incremental impacts of expanding the comprehensiveness of the removal alternatives.***[13]

The FS says that alternative 5N would have 5 times the impact to the water column as alternative 4N. However, the USACE Report says that these are addressing the same area and mass of sediments, so the water column impacts should be the same. Thus, the FS report is flawed.

The FS made claims that (a) there will be gaps in the sheet piles, (b) there needs to be openings to balance water pressures (c) there is potential for river-induced scour adjacent to the sheet pile, (d) there is a risk of resuspension during sheet pile installation and removal and (e) there is a potential for cross-contamination to non-impacted material under impacted sediment. The USACE Report explains why none of these are issues of concern for the San Jacinto site. The text says:

> *Leakage through shallow walls can be controlled by lining the walls, adding sealants and incorporating the walls within shallow berms, which would allow excavation in the dry. Placing the walls in shallow areas would allow the walls to be taller, limiting their potential overtopping. In deeper waters, sheet pile walls limit flow through the site and can restrict flow to the surface, limiting erosion of residuals, while silt curtains direct flow along the bottom of the water column, promoting the transport of resuspended sediment and allowing*

[13] USACE 2015 p. 137

> *erosion of residuals. Accumulated resuspended sediments at the base of the walls can be readily capped or covered in place, if not removed by a suction dredge.*[14]

We agree with the USACE Report conclusion that the FS has substantially over-stated the potential dioxin release and should be revised to include the control recommended in these alternatives.

As shown in Tasks 11 and 12, the mass of potential resuspension from installing and removing sheet pile is a small fraction of the reduction by using sheet piles compared to silt curtains. The risk of driving contamination deeper is only a significant concern when NAPL is present, which is not the case at the San Jacinto site.

In addition, the FS made assumptions about the post-dredge residual concentrations, which the USACE Report did not agree with. The USACE Report states that if the dredge residuals have a concentration equal to the last dredge pass, then a clean-up pass should be added to the dredge plan. Also, if there is mixing of contaminated sediment in a sand cover, then the sand cover layer should be placed in 2 layers, so that the bioactive zone will be clean following remediation.

10. Study Task 14 Model evaluation of full removal alternative 6N in the FS and any new alternative developed under Task 12

The USACE Report states that this model is still being performed. This needs to be completed.

11. Study Task 15 Evaluate floodplain management and impact considerations of any new alternatives developed under Task 12

Task 15 relates to whether there is any floodplain impact of the construction options for the site. The USACE Report states that LTFATE was used for modeling. The "FEMA standard" is actually HEC-RAS for such modeling. It's not that LTFATE is necessarily wrong, and it is true that FEMA requirements are likely to be waived as this is a federal project, but the USACE Report is not using the industry standard base models for their comparisons. It's unclear what impact using the revised models will have on the results for any of the options.

12. Study Task 16 Project long-term effects of capping alternative compared to full removal alternative

The USACE Report states that: *Based on information in the Feasibility Study, it was determined that the TCRA site is primarily depositional with very little erosion potential.*[15] This statement needs to be evaluated further because:

- Typically the depositional site of a bridge structure is the upstream side; this is true for a "typical" rainfall event (like what they modeled), but the result is the opposite for a hurricane. It's also possible that with global warming and sea level rise that this reach will experience greater tidal influence, which will also decrease the depositional likelihood of this area

[14] USACE 2015 p. 139
[15] USACE 2015 p. 148

- Defining this area as depositional has a trickle effect in the modeling, where the differences shown between the construction methods with respect to resuspension, etc. may be exaggerated.

In Task 16, we note that the post-dredging dioxin fluxes that are predicted by the RECOVERY model for Scenario 6N are highly sensitive to the 3 cm thick layer of highly-contaminated (>1,000 ng/kg) residuals. This number was taken from the FS report. We seriously questions whether dredging residuals of this high concentration would occur, given that the dredging design is to target residual concentrations down to 200 ng/kg. As noted in comments under Study Task 11, the residual concentrations would be reduced by dredging deeper into sediment with lower contaminant concentrations. Also, on Page 141 the USACE Report states that "if a 3-inch layer of dredge residuals having a concentration of the last dredge pass are presumed, then a clean-up pass should be included in the dredge plan to reduce the future exposure." So it would seem appropriate to eliminate or reduce the residue for a complete removal scenario.

We are not certain of its impact on calculations, but the estimates of 3 to 6% organic carbon in native sediment are not realistic for the system, with the possible exception of on-Site waste materials. In this system, a typical range for organic carbon in native sediments is 1 to 2%, with a median value nearer the lower end of that range. The impacts of this assumption on calculations should be further evaluated in the revised FS.

13. Study Task 17 Assess the potential impacts to fish, shellfish and crabs from sediment resuspension as a result of dredging.

Regarding Tasks 17 and 20, there is additional direct measurement data that was not considered and might impact the calculations and deserved consideration. In the TCEQ TMDL project, the University of Houston measured dioxins and furans in fish, crabs, sediment, and water (dissolved and particulate phases) near the Site and throughout the tidally-influenced San Jacinto River and Houston Ship Channel system down to Galveston Bay. The total number of samples was well over 100 in each phase. Their BSAFs for 2378-TCDD in catfish averaged 0.23, one order of magnitude higher than the value assumed here. The average measured BSAF for 2378-TCDD for blue crab was 0.28, more than 100 times higher than the value assumed here. These were calculated from organic carbon-normalized sediment concentrations and lipid-normalized tissue concentrations. The documents are available from the Texas Commission on Environmental Quality (http://www.tceq.state.tx.us/waterquality/tmdl/26-hscdioxin.html) as well as a variety of peer-reviewed papers (see, for example Suarez et al, 2005, 2006, 2007; Dean et al, 2009). The discrepancy between the assumptions and these measurements should be investigated, and the impact of uncertainty on the calculated bioaccumulation potential and protective concentration levels should be calculated and presented in the USACE Report.

14. Study Task 18 Assess potential for release of material from Waste Pits caused by storm during removal/dredging operations.

Regarding Task 18, we believe the risks of a hurricane or tropical storm during dredging operations could be reduced by performing the work during the roughly half of the year when they seldom occur. The impacts could also be substantially lessened by doing the work in phases, with relatively little exposed sediment at any time, and by surrounding the Site by a sheet pile wall reinforced by the clean armor stone that is being removed from the cap surface. In addition, these risks would be minimized by simply watching the weather forecasts for potential storms. With advance warnings, there would be time to take measures to prevent releases.

The Site is located in the Gulf Coast region where there is the potential for a tropical storm or hurricane during predicted seasonal periods. Due to this factor, PRPs should not schedule mitigation / dredging during such time periods. However, this Site has not withstood rain events that were not considered significant and thus required the addition of larger stones to sure up the structure.

The use of sheet piling has been noted at other removal sites as an effective means of control for sediment removal in aquatic environments. The sheet piling should be place in small sections and should not require large staging areas for materials holding. The idea is not to proceed "hastily" as mentioned, but rather to proceed with caution and observation of the area to lessen the potential of sediment release.

15. **Study Task 19 Estimate the rate of natural attenuation in sediment concentrations/ residuals.**

Due to the absence of recent Site sediment sampling we do not know if there has been seepage of contamination from the sides or toe of the existing cap. As previously stated in the General Comments, a cap sampling plan has been proposed to address this concern but has not yet been implemented.

16. **Study Task 20 Assess the appropriateness of the preliminary sediment remediation action level**

Risk of exposure for the adult fisherman and the child recreational visitor has been assigned weighted action values. The concern is that the value assessed to the child is too high given that children consume more water, air and food per kilogram of body weight that adults do.

CONCLUSION

The Technical Review Team appreciates the opportunity to provide our comments to the EPA regarding the draft USACE evaluation report. As we note, the Technical Review Team has significant concerns regarding the draft evaluation report, and we look forward to receiving a response to these comments and/or an additional draft report for further review. If you have any questions regarding our comments, we would welcome the opportunity to answer them.

Sincerely,

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